DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified technical topics to which small businesses may respond in the first fiscal year (FY) 99 solicitation (99.1). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical program managers.

Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

It is expected that the majority of DARPA Phase I awards will be Firm Fixed Price contracts. Phase I proposals **shall not exceed $99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor. DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately $375,000; the second 10-12 months of incremental funding should also be approximately $375,000. The entire Phase II effort should not exceed $750,000. It is expected that a majority of the Phase II contracts will be Firm Fixed Price-Level of Effort or Cost Plus Fixed Fee.

The responsibility for implementing DARPA's SBIR Program rests with the Administration and Small Business Directorate (ASBD). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/ASBD/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714

(703) 526-4170
Home Page http://www.darpa.mil

SBIR proposals will be processed by DARPA ASBD and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., "The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution" (refer to section 4.2 Evaluation Criteria - Phase I), twice the weight of the other two evaluation criteria. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the closing date of this solicitation. For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information. Successful offerors will be expected to begin work no later than 28 days after contract award. For planning purposes, the contract award process is normally completed within 45 to 60 days from issuance of the selection notification letter to Phase I offerors.

On a pilot basis, the DoD SBIR Program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. DARPA encourages Fast Track Applications between the 5th and 6th month of the Phase I effort. Technical dialogue with DARPA Program Managers is encouraged to ensure research continuity during the interim period and Phase II. If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will not exceed $40,000.

DARPA 1999 Phase I SBIR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Commercialization Strategy ______

   i. Key Personnel, Resumes ______

   j. Facilities/Equipment ______

   k. Consultants ______

   l. Prior, Current, or Pending Support ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Company Commercialization Report - Appendix E ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. **Do not** use a cover. ______

   c. **Do not** use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 24 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 24 page limit do not send appendices, attachments and/or additional references. ______

   c. Company Commercialization Report (Appendix E) is not included in the page count. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed Appendices A and B ______

   b. Four photocopies of original proposal, including signed Appendices A, B and E. ______

INDEX OF DARPA FY99.1 TOPICS

SUBJECT/WORD INDEX TO THE DARPA FY88.1 TOPICS

DARPA 99.1 TOPIC DESCRIPTIONS

DARPA SB991-001 TITLE: Fabrication Process Development for High-Performance Micro Inertial Measurement Units

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Improve performance and environmental tolerance of Micro Inertial Measurement Units (IMUs) by eliminating performance barriers and theoretical limitations imposed by current surface micro-machining techniques.

DESCRIPTION: Extreme miniaturization of sensors such as (IMUs) has become possible with the development of micro-machining technologies. In addition to vastly reducing size and weight, unprecedented reductions in cost and power consumption have been achieved. Unfortunately, performance has been the trade-off. Sensor structures created from very thin films have low lateral sensitivity, and lack structural rigidity perpendicular to the substrate. Bulk micro-machining techniques provide promise, but may impede multi-axis measurement. In order to achieve the level of (IMU) performance necessary for the next generation of small missiles, hybrid micro-machining processes need to be developed. It is envisioned that a combination of techniques from bulk micro-machining, surface micro-machining, silicon-on-insulator (SOI), or other processes could be combined or altered to form a defined fabrication process optimized for the development of robust, high-performing, single-package (IMUs). The goal of this topic is to address process and fabrication issues that theoretically limit (IMU) performance goals of both components and the integrated inertial unit. Performance issues include those of sensing-rate performance, performance over temperature, performance under conditions of dynamic roll, high acceleration, high frequency shock, and vibration. Integration issues include compromises between package size, multiple axis sensing, electronics packaging, common use/function designing, bonding, cross talk, mechanical limits, etc. Innovative approaches that provide short-term implementation without limiting long-term advancement are sought.

PHASE I: Identify specific fabrication techniques that address the enhancement of one or more (IMU) performance issues. Quantify the advantages of your approach, and conduct proof-of-principle experiments to verify proposed techniques. Short-term performance goals for a bias of 30 (/hr, with a dynamic range of (2,000 (/sec , over a temperature range of 0(C to +50(C must be ascertained achievable. Additionally, approaches toward the expansion of these goals to 1 (/hr, with a dynamic range of (15,000(/sec , over a temperature range of -40(C to +75(C must be, at least, theoretically discerned.

PHASE II: Validate your process design by fabricating brass-board prototype(s) of a (IMU) or (IMU) components suitable for small missile applications, and with performance specifications at or exceeding those named above - teaming with government, industry, or academia foundries as necessary. Confirm performance through laboratory testing. Component-only demonstrations must be substantiated with judicious examination of integration issues.

PHASE III DUAL USE APPLICATIONS: Commercialization of both (IMU) technologies and the fabrication processes developed are expected. (IMU) marketes extend from numerous automotive and aeronautical applications to mining and oil-drilling applications to helicopter rotor and robotic camera stabilization applications. Potential market sales of small, low-cost units are astronomical. Additionally, innovative processing techniques developed under this effort could be applied to other MicroElectroMechanical System (MEMS) devices to improve performance and/or component longevity.

KEYWORDS: Micro Electro-Mechanical Systems (MEMS), Inertial Measurement, Micromaching

REFERENCES:
1. Juneau, T. N., et al., “Commercialization of Precision Inertial Sensors with Integrated Signal Conditioning,” Proceedings of Sensors Expo, 1998, San Jose, CA
2. Proceedings of the Eleventh Annual International Workshop on Micro Electro Mechanical Systems, IEEE Catalog Number 98CH36176, Heidelberg, Germany, 25-29 January 1998
3. Ayazi, F., and Najafi, K., “Design and Fabrication of a High-Performance Polysisicon Vibrating Ring Gyroscope,” Proceedings of the Eleventh IEEE/ASME International Workshop on MEMS ’98
4. Weinberg, M. et al., “Micromachining Inertial Instruments,” SPIE Proceedings, Vol. 2879
5. Proceedings of the Solid-State Sensor and actuator Workshop, TRF Catalog Number
96TRF-0001, Hilton Head Island, SC, 3-6 June 1996
6. Macomber, G. R., and Fernandes, M., "Inertial Guidance Engineering," Prentice-Hall, Englewood Cliffs, New Jersey, 1962
7. Wringley, W., Hollister, W. M., and Denhard, W. G., "Gyroscope Theory, Design, and Instrumentation," MIT Press, 1969

DARPA SB991-002 TITLE: Flexible, Thin Films with Low Sheet Resistance and High Transparency

KEY TECHNOLOGY AREA: Materials and Processes

OBJECTIVE: The objective of this task is to develop transparent, conducting electrodes for flexible displays.

DESCRIPTION: Soldiers in the field require lightweight displays which can be rolled up and stored in a small container. With the rapidly maturing light emitting polymer field, an inexpensive, flexible display can be realized if a compatible transparent conductor can be developed. The market for transparent conductors has been dominated by indium tin oxide (ITO) and related compounds for 40 years [Ref.1]. Although usage of ITO films is widespread, these semiconducting films have limitations that are hindering the development of new technologies. One limitation is the relatively high sheet resistance which limits the area for a single display panel to 30 cm x 30 cm. The high sheet resistance also limits the speed and efficiency of the display. The primary problem with ITO for flexible displays is that ITO is brittle and will crack under slight deformations. The goal of the project is to develop flexible thin films having sheet resistance's of ~1 ohm/sq. The wavelength band of the transmission window should correspond to the spectral sensitivity of the human eye and have a minimum transmittance of 70% from 500-600 nm. The film growth should not require excessive substrate temperatures and fabrication procedures should be compatible with standard thin film processing techniques. Fabrication costs of the flexible films should be comparable to ITO. The electrical properties of the film should not change substantially when flexed to a 2-inch radius of curvature.

PHASE I: Demonstrate the fundamental technologies required to produce flexible thin films with low sheet resistance and high transparency.

PHASE II: Demonstrate compatibility with processes and materials used in light emitting polymer devices. Perform reliability and lifetime measurements on the flexible films at current densities typically used in light emitting diodes.

PHASE III DUAL USE APPLICATIONS: Applications for flexible, highly conducting, transparent, thin films include displays that are portable, thin, and conformal. Other applications areas for transparent conductors are protective coatings, solar cells, heat reflectors, and anti-static surface layers.

KEYWORDS: Transparent Electrodes, Thin Films, Flexible Displays

REFERENCE: H.L. Hartnagel, A.L. Dawar, A.K. Jain, and C. Jagadish, "Semiconducting, Transparent, Thin Films," Institute of Physics Publishing, Bristol, U.K., 1995

DARPA SB991-003 TITLE: Detection of Underwater Buried Mines

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Define and demonstrate a simple prototype acoustic system that can significantly reduce the error rate for detection and classification of underwater buried mines in littoral environments, despite the fact that the mines may have reflectivity that is comparable to the surrounding clutter. The system should potentially have a high area coverage rate (i.e., it should not depend upon close-up examination of every spot on the ocean bottom).

DESCRIPTION: The objective is defined in terms of technical needs and not in terms of identified technology. In fact, it is tempting to state that the problem is too difficult and that a reliable and general solution does not exist. Dolphins in the Bahamas, however, can reliably find small, low-sonar-cross-section fish (some of which have no swim bladders) that have buried themselves in the sandy bottom, both in relatively bare areas and in areas with vegetation. Detection can occur at a distance of several meters. We are interested in identifying and exploiting the methods that are employed by these and other animals (e.g., biomimetics) and increasing the area coverage rate beyond that exhibited by the animals. Interest exists in the development of (1) appropriate signal processing/imaging techniques and (2) suitable acoustic sources/detectors as required. Multiple awards are anticipated and collaboration among offerors might be advantageous for successful completion of the effort.

PHASE I: Development of a signal processing system (in software) and a feasibility demonstration on simulated or pre-existing data. Identify new methods for suitable acoustic power generation and detection, and develop configurations which maximize transducer and/or system performance. Initiate development of a commercialization plan.

PHASE II: Complete signal processing software development and acoustic source/receiver prototype fabrication and demonstrate combined software/source/receiver performance on data obtained under controlled conditions and from a littoral environment.

PHASE III DUAL-USE APPLICATIONS: Undersea exploration for oil/mineral deposits and salvage operations; detection of terrestrial nonmetallic gas lines.

KEYWORDS: Littoral Mines, Biomimetics, Underwater Acoustics

DARPA SB991-004 TITLE: Multi-Functional Materials and Structures

KEY TECHNOLOGY AREA: Materials, Materials Processing, and Structures

OBJECTIVE: Demonstrate the feasibility and synthesis of materials and structures having multifunctional capabilities. Materials and fabrication techniques conducive to rapid prototyping are encouraged.

DESCRIPTION: Research and development leading to the creation of multifunctional materials and structures which enable multiple and simultaneous functions (e.g., structural, electromagnetic, sensing, power generation, etc.) to be performed by a single material system. While there are many DoD systems and components that would benefit from such materials, efforts should address multi-functional materials for mesoscale devices for the individual soldier and small, autonomous systems. At this size range (“sugar cube to fist”), the use of multi-functional materials should provide a significant advantage in such attributes as affordability, weight, volume, power consumption and/or performance. Fabrication techniques conducive to rapid prototyping are encouraged due to the ability to quickly produce test structures with the appropriate form, fit, and function.

PHASE I: In detail, define the materials system, the application, and the approaches for the design and manufacture of multifunctional materials and/or structures. Perform preliminary experiments demonstrating the ability to create such materials / structures. Quantitative advantages of the use of multi-functional materials in the selected application must be presented.

PHASE II: Prototype the multi-functional material system and demonstrate its specific advantages in the chosen application. Approaches for manufacturing of the prototype must be commensurate with full-scale production. Cost models for full-scale production should be developed.

PHASE III DUAL USE APPLICATIONS: The benefits of using multi-functional materials will be pervasive for many commercial applications. This is especially true in areas where power, volume, weight and/or cost are critical. Applications for which this concept is expected to have especially high commercial pay-off include portable systems, robotics, automotive, and spacecraft.

KEYWORDS: Multi-Functional Materials, Materials Development, Robotics

DARPA SB991-005 TITLE: Use of Nanotubes in Tools for Lithography and Microfabrication

KEY TECHNOLOGY AREA: Electronics; Manufacturing Science and Technology (MS&T); Materials, Processes, and Structures

OBJECTIVE: Exploit properties of carbon nanotubes for use in tools for lithography, semiconductor and micromechanical (MEMS) device fabrication, and metrology.

DESCRIPTION: The structural and electrical properties of carbon nanotubes enable a variety of implementations in tools for fabricating microstructures in semiconductor and related technologies. Nanotubes are candidate replacements for sharp tips for use in tools such as scanning probe microscopy, atomic force microscopy, and field emitters of electrons and ions. These tools provide solutions to a range of problems in sensing, pattern writing, measurements, deposition, etching, etc. In-situ growth may minimize problems of handling and mounting of the tips, as well as providing enhanced characteristics for operation in the tool. Control and reliability offer challenges to successful integration into tools for microfabrication. End-use applications often require an exacting combination of positioning, sensing, actuation, and associated instrumentation.

PHASE I: Explore the requirements of one or more applications in the broad areas indicated above. The contractor should show evidence of a close working relationship between the nanotube expert and the equipment manufacturer that will allow identification of technical challenges of tool integration, as well as technical approaches that indicate a path to successful integration. Project specifications of tool to be built during Phase II.

PHASE II: Fabricate a prototype tool using the nanotube component, integrate into a test configuration, and characterize the system performance.

PHASE III DUAL USE APPLICATIONS: The development will provide potential solutions in a key area of microelectronics and micromechanical structure fabrication. As the semiconductor industry moves to smaller feature sizes for integrated circuits, the push for efficient production places stringent demands upon metrology, microscopy, and mask and wafer writing, inspection, and repair. The small nanotube tips will provide improved reliability and stability of these very sensitive systems.

Other areas of applications include displays, quantum effect devices, and the myriad MEMS applications beyond conventional microelectronics.

KEYWORDS: Nanotubes, Carbon, Lithography, Microfabrication, Proximal Probes.

REFERENCE: Special Issue on Nanometer-scale Science and Technology, Proc. IEEE, No. 4, vol 85, April 1997.

DARPA SB991-006 TITLE: Low Cost, High Performance Lasers for RF Photonics Applications

KEY TECHNOLOGY AREA: Electronics; Sensors

OBJECTIVE: Promote the development of low cost to manufacture designs for lasers for use in photonic transport of analog Radio Frequency (RF) signals in communication, radar and other RF signal processing systems.

DESCRIPTION: The application of photonic (laser) technologies for the transport of RF signals is a well established application that places severe performance requirements on the lasers used in terms of Relative Intensity Noise (RIN), output power and RF modulation response. For low RF frequencies (0.1-5 Ghz) direct modulation is possible and desirable, while at higher frequencies external modulators may be required. Semiconductor laser diodes and diode pumped solid state lasers have been used for these applications but to achieve the required performance relatively high cost to manufacture designs have typically resulted in limiting the range of potential applications, particularly large arrays requiring many photonic links. This program seeks to support innovative approaches to low cost to manufacture laser module designs that can meet high performance RF-Photonic link requirements. Candidate technologies are expected to exploit recent advances in photonic device and heterogeneous material integration. Of particular interest are means to incorporate emerging low cost to manufacture vertical cavity surface emitting laser (VCSEL) array modules and advanced integrated Distributed Feedback Laser (DFB) laser designs to achieve relatively high power sources capable of either direct modulation with high slope-efficiency, or of pumping low RIN solid state laser modules. Approaches that make use of alternatives to intensity modulation or which integrate external modulator components with laser source are also of interest.

PHASE I: Develop proof of concept design, either through fabrication of prototype components or by detailed modeling of designs based on demonstrated performance of existing components.

PHASE II: Develop and demonstrate a fully functional prototype capable of demonstrating critical functionality, providing design documentation for a full scale implementation.

PHASE III DUAL USE APPLICATIONS: Potential applications for low cost to manufacture RF Photonic lasers include remoting of antennas for cellular and micro-cell radio systems for use in military and commercial applications, the distribution of cable TV signals, signal processing for phased array antenna beam forming, and probing of microwave and milli-meter wave monolithic integrated circuits.

KEYWORDS: Lasers, RF Photonics, Analog Optical Links, Optically Controlled Phase Array Radar

DARPA SB991-007 TITLE: Integrated Solutions for Packaging of High Power Electronics

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Create new packaging technologies for high power switching electronic devices and circuits.

DESCRIPTION: Innovative packaging technologies are needed for integration of new classes of high-power solid-state electronic components, such as diodes and switches, with sensors and microelectronic control within a half or full bridge module and with currents in the 100-350A range and voltages in the 1200-1600V range. Furthermore, new classes of high power handling wide bandgap semiconductor electronics are emerging that may dissipate very high powers or have very high power densities (on order of 107 W/m2). These new devices and circuits are under development to meet the widespread military and commercial needs for switching devices and integrated circuits that can satisfy the very high-current and high-voltage requirements of power transmission and distribution systems, hybrid- and all-electric vehicles, more-electric aircraft, and other types of electrical equipment and machinery. The device junctions in certain wideband semiconductor materials may reach temperatures of 300-400øC where application of conventional assembly and packaging technologies is difficult. Innovations are needed for an integrated solution to packaging of high power modules, including aspects of advanced interconnection, packaging, and assembly of these components and modules, package substrate materials, interconnect metallizations, thermal mitigation approaches, die attach, and power management. All offerors should address relevant issues of transient and steady-state operating temperatures of the packaged module because it is of critical importance. Technical approaches that are self-contained and minimize needs for external sources of thermal mitigation are encouraged. As applicable, offerors should provide a cost-performance analysis of the proposed approach.

PHASE I: Perform fundamental experiments and computer simulations that confirm feasibility of the technology for high power packaging. Demonstrate thermal stability of packaging technology.

PHASE II: Develop cost-effective processes and materials for high power packaging. Demonstrate critical aspects of packaging technology for large-scale applications.

PHASE III DUAL USE APPLICATIONS: Commercial and military applications for packaged high power devices and circuits include, switching devices and integrated circuits for electrical power transmission and distribution systems, hybrid- and all-electric vehicles, more-electric aircraft, and other types of electrical equipment and machinery.

KEYWORDS: Packaging, Electronic Packaging, High Power Electronics

DARPA SB991-008 TITLE: Miniature, Ultra-Low Phase Noise Oscillators for High Performance Analog-to-Digital Converters (ADCs)

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: To develop ultra-stable, low power oscillators for the ADCs to be used in future generations of digital receivers.

DESCRIPTION: The current generation of digital transceivers being developed requires at least one mixer. In order to combat jamming and interference, the front end of a receiver may require 100 dB of instantaneous dynamic range over 100 MHz of bandwidth to enable cancellation of these signals. The resulting mixers would require high power consumption, making them impractical for man portable systems. Additionally, synthesizers with required thermal phase noise of -180 dBc/Hz at microwave frequencies are not available. Current oscillator techniques for low phase noise applications are also too bulky for use in miniaturized receivers. It is well known that it is possible to use an ADC (sampled at GHz frequencies) to directly sample the Radio Frequency (RF) signal with the down conversion performed digitally, removing the limitations of analog down conversion circuitry. However, one of several major limitations on accomplishing the high dynamic range includes jitter levels approaching 1 femtosecond for ADC sampling clocks in the GHz range. Efforts should address ideas for developing ultra-low phase noise oscillators that can be miniaturized for use in digital receivers (e.g., in a Personal Computer Memory Card International Association (PCMCIA) format). For example, a 0.2” x 0.5” x 0.5” oscillator (at 6 GHz) with a thermal floor of -170 dBc/Hz and 1/f^n corner frequencies less than 100 kHz (10 kHz preferably) could provide the characteristics needed for a transportable UHF and possibly L-band direct sampling digital receiver.

PHASE I: In detail, define the physical principle that will lead to the development of the ultra-low phase noise oscillator and quantify the expected benefit.

PHASE II: Develop a breadboard system to test the physical principle established in Phase I.

PHASE III DUAL USE APPLICATIONS: The development of ultra-low phase noise oscillators will greatly enhance performance capabilities of ADCs and the systems into which they are inserted (such as digital transceivers). The true all digital transceiver will inherit all of the benefits of Moore’s law as digital technology progresses into the 21st century. Potential applications include software programmable radios (e.g., personal communication services [PCS]), enhanced communication payloads for Unmanned Air Vehicles (UAVs), and multi-mode receivers for military aircraft (such as F-15).

KEYWORDS: Low Phase Noise Oscillator, Analog-to-Digital Converter, ADC, Low Jitter, Stable Clock

DARPA SB991-09 TITLE: Streaming Multi-Sensor/Multimedia Software Viewers for the Warfighter

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Develop algorithms, software, and special hardware (if needed) to allow a tactical warfighter to view integrated streams of multimedia and multi-sensor data, such as video, Synthetic Aperture Radar (SAR), Moving Target Indication (MTI), Tactical Digital Information Link (TADIL) reports, Signal Intelligence (SIGINT) reports, Electro-Optical Infrared (EO/IR) imagery, 3-D terrain and feature data, and situation awareness overlays. The warfighter should be able to tailor the quality, quantity, and specific content of a multimedia stream to fit his individual mission needs, priorities and bandwidth available. This “viewer application” should interact with multimedia servers and underlying network mechanisms to adapt quality and content to available communications resources and characteristics. To achieve low life-cycle costs and interoperability for coalition operations, maximum use should be made of international commercial standards and products, developing new technology only where necessary to incorporate military specific formats, data types, communications protocols, or viewing requirements. The viewer should operate in a range of communication venues from broadband fiber to low-bandwidth wireless tactical radios. The viewer should be able to support a variety of military operations from sensor-to-shooter applications in conventional warfare to surveillance and monitoring for force protection and peace-keeping operations.

DESCRIPTION: The warfighter of 2010 will have access to an emerging set of sensor, intelligence, and command and control data that is "streamed" down a network from its source to a warfighter's workstation, which maybe mobile or even worn like clothing. This data will include continuous streams of multimedia information (for example, video, computer graphics, images, audio, structured computer data, text) and multi-sensor data (for example, EO/IR video and images, SAR strip maps, slices of 3-D site and terrain models, and continuous SIGINT and MTIs). The warfighter will need to select portions of this information and combine it into a view that is directly related to his specific mission and function. The quality, quantity, and content of the viewed information must adapt to the available network and communications resources and match the warfighter's priorities. To be affordable, integrated multimedia and multi-sensor viewing applications need to be built around commercial standards and products using commodity computing equipment and displays, for example, a pop up viewer activated from a World Wide Web browser. For coalition operations, it is especially important that software viewers fit into commonly available information frameworks and international standards that are available to foreign nations, for example those of the Multi Media and Hypermedia Experts Group (MHEG) and the Moving Pictures Experts Group (MPEG). While emerging commercial products will answer much of the warfighter's needs, special military data formats, communications environments, and information needs will require some customization, translation, and extensions of commercial solutions. Efforts of interest include identifying future commercial products conforming to emerging international meta data and streaming multimedia standards, identifying unique Department of Defense (DoD) requirements and algorithmic modifications of commercial products needed for military applications, and demonstrations of streaming multimedia and multi-sensor viewers using existing military networks and radios. The commercial niche in viewers is to support single products across the Internet. While the viewers support MPEG and the Joint Photographics Expert Group (JPEG) standards and view a product in isolation and would be useful in the military, the military desires that all the information be placed onto one scene, thus integrated for decision making. This integration is the key for DOD. The DOD niche is a combination of applying real-time reconnaissance feeds that in many cases have mission/life critical implications. The viewer should be of the commercial nature but the product that is presented into the viewer should be integrated for the warfighter. Thus an MPEG video stream from a Unmanned Aerial Vehicle (UAV) could be viewed on a Joint Mapping Tool Kit (JMTK) map product coupled with imagery of the same area. Commercial viewers as the primary means would enable easy scaling across services and coalition forces. The integrated approach to handle multiple type streams and products within the viewer would allow tailoring with an applications such as a US Army command post that has systems such as Maneuver Control (MCS), Advanced Field Artillery Tactical Data System (AFATDS), etc. Each application within a viewer could have UAV, 3-D Virtual Reality modeling Language (VRML), and MTI tracks, OTH Gold Tracks, etc., as needed is the DoD product desired.

PHASE I: Develop an approach for viewing integrated multi-sensor, multimedia streams over tactical networks. Explain how the approach supports tailored, bandwidth-adaptive viewing. Explain how the proposed capability builds on standards-based commercial technology, defining any extensions or modifications of commercial approaches and products required for military operation. Select one or more military applications for analysis and quantify the expected operational benefits. The viewer should be a universally available viewer so that it can be populated throughout the Services, integration is open to multiple products that are streamed or archived with usual meta data information. The integration architecture is open for new products. Viewer must provide the warfighter the selectivity to adopt views based on viewing needs, computing infrastructure and communications infrastructure.

PHASE II: Develop a streaming multi-sensor, multimedia viewer for military applications and data sources using commercial components and international standards. Demonstrate its effectiveness in a military scenario. Deliver documentation of the results and an analysis of the potential impact on military operations. Define any required extensions to international standards for military applications.

PHASE III DUAL USE APPLICATIONS: Viewers for streaming multimedia are emerging as a major growth area for Internet electronic business and entertainment. Integration of direct multi-sensor feeds into powerful viewer applications will let the user control the content and format of his display and adapt quality and content to available bandwidth and network characteristics. Such a viewer will find ready commercial markets in distance learning, distributed interactive entertainment, electronic shopping, and security and monitoring. Commercial technology in turn will provide cost-effective commercial products supporting a new generation of multi-sensor situation awareness and sensor-to-shooter integration for law enforcement as well as new approaches to monitoring and surveillance for combating asymmetric threats.

KEYWORDS: Video, Protocols, Multi-Media, Software, Data Transmission, Tactical Digital Information Link, TADIL

DARPA SB991-010 TITLE: Model-Based Infrared and Synthetic Aperture Radar Fusion for Object Level Change Detection

KEY TECHNOLOGY AREA: Sensors; Computing and Software

OBJECTIVE: Develop model-based infrared and synthetic aperture radar (SAR) fusion algorithms that demonstrate an order-of-magnitude improvement in false alarm performance over existing single sensor object level change detection algorithms.

DESCRIPTION: Object level change detection (OLCD) algorithms extract object feature information over time from repeated sensor observations. The resulting image features are combined and stored in a database to yield a persistent baseline for detecting object level image changes. OLCD provides increased false alarm immunity by eliminating false alarms that match previously detected false alarms stored in the database. Because state-of-the-art OLCD algorithms are "view centered," their performance can be significantly degraded by the unexpected appearance of false changes caused by, among other things, variations in sensor collection geometry, solar illumination angles, poorly calibrated sensors, and object masking effects. Additionally, state-of-the-art OLCD approaches typically exploit single sensor phenomena, rather than combine cross-phenomenology multi-sensor change cues to confirm or deny change. The purpose of this research is to achieve an order-of-magnitude improvement in false alarm performance by developing algorithms that predict multi-sensor effects caused by apparent object level change, and fuse multi-sensor evidence to eliminate nuisance changes associated with these effects. The government will provide a multi-sensor data set for developing and evaluating models and algorithms. The data set will contain large quantities of spatially and temporally coincident infrared and SAR images collected during a 30-day period in early summer 1998 over a 4km x 6km Eglin Air Force Base test range C-72. Test data will be sequestered from this data set, and will be used by the government to produce statistically significant receiver operating curves to assess change detection performance.

PHASE I: Design and predict the performance of a model-based multi-sensor OLCD algorithm that eliminates apparent changes caused by man-made objects as a function of variations in sensor collection geometry and solar illumination angles. Man-made objects include military vehicles, facilities, line-of-communication towers, hangers, runway control towers, maintenance trailers, and fences. The algorithm should exploit phenomenology models to predict illumination and collection geometry effects on object and background signatures, and fuse SAR and infrared data to confirm or deny apparent changes. Algorithm performance should be predicted under a range of operating conditions using experimental and theoretical methods.

PHASE II: Develop, fully evaluate, and demonstrate a prototype of the algorithm designed in Phase I. If required, the government will provide 3D geometric models and prediction software for a limited set of man-made objects contained in the government furnished data set. Evaluation procedures will include a methodology for truthing real and apparent changes, as well as counting and scoring man-made object change detection and false changes. Deliver an object-oriented software implementation of the algorithm that can be demonstrated in the laboratory on a stand-alone basis, or incorporated in other DARPA technology products or systems as recommended by the proposer.

PHASE III DUAL USE APPLICATIONS: Dual use applications include any process requiring correlation of information from disparate sources for the purpose of detecting changes in natural and man-made objects in a low false alarm environment. Potential application areas include those requiring immediate determination of situation awareness such as transportation, environmental or natural disaster monitoring, medical emergencies, dynamic business operations, and complex manufacturing or chemical processes involving multiple sources of instrumentation and observation. Deliver a pre-production, stand-alone configuration that supports the most promising commercial application.

KEYWORDS: Change Detection, Automatic Target Recognition, Sensor Fusion, Site Modeling

DARPA SB991-011 TITLE: Structures for Complex Adaptive Systems (Fractal Architectures)

KEY TECHNOLOGY AREA: Command, Control and Communications (C3), Computing and Software

OBJECTIVE: Research and development leading to specifying, designing, implementing, describing, and adapting distributed software systems based on a fractal architecture approach for use in managing complex activities.

DESCRIPTION: Adaptation of a process might include removing system elements or rerouting message paths to support tighter feedback control loops. Approaches that focus on the definition of functional, tailorable components that can be composed in a fractal manner in order to achieve system dynamics objectives. It is expected that the components would operate at different hierarchical levels and different levels of granularity while sharing the same composable architecture. The system should exhibit similar characteristics at all levels without excessive overhead. Systems under dynamic operational stress, primarily dynamic process and workflow management and command and control are of particular interest. Efforts of interest include:

PHASE I: In detail, define the system architecture and design approach. Outline the system design, description, and adaptation approach. Describe how adaptation would occur and characterize performance issues for systems of different scales. Emphasis should be on exploiting the fractal nature of the architecture for unprecedented adaptive and dynamic charateristics.

PHASE II: Develop an initial implementation of the adaptive distributed fractal software systems and demonstrate them on a significant example of a dynamic software system. Complete documentation of test cases and results must be delivered. Emphasis should be on demonstrating the power of a fractal architecture approach and its use in dynamic environments.

PHASE III DUAL USE APPLICATIONS: The development of adaptive fractal systems will lead to new commercial markets for developers of complex systems dealing with dispersed entities in a highly dynamic environment. The potential of a fractal design to address the composability and adaptability of systems for highly dynamic environments could be a significant breakthrough for complex systems. "On-the-fly" re-design of complex systems will greatly enhance the utility of both commercial and military applications.

KEYWORDS: Systems Technology, Adaptive Workflow Management, Adaptive Software, System Design

DARPA SB991-012 TITLE: Information Warfare Simulation Architecture

KEY TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Development of federation architectures that supports the incorporation of Information Warfare (IW) in simulations.

DESCRIPTION: Research and development leading to implementation architectures in which highly classified IW techniques can be properly represented in simulation exercises while remaining insulated from other simulations enabling them to run at lower classification levels. Based upon the general, widely known methods used in IW, this effort must define the interactions required for proper representation of IW in simulations. It must account for the results of IW to properly affect the battlespace and for other actions within the battlespace to affect the operation of IW systems. Considering the various interactions, options for federation topographies must be explored. The capabilities and limitations of such topographies and conditions for their employment must be identified. The architectures developed must be shown to accommodate all identified required interactions.

PHASE I: Identify the interactions required between IW federates and simulations representing the rest of the battlespace. Identify potential architectures which accommodate these interactions and address classification difference between federates.

PHASE II: Develop an instance of one or more of the architectures. Demonstrate performance with conceptual IW models and a DoD simulation system that explicitly addresses the movement of battlespace information. Report on key metrics of the architectures' performance and the requirements to implement it with models of actual IW capabilities.

PHASE III DUAL USE APPLICATIONS: The commercial sector is more reliant than ever on information technology and significant infrastructures have been created to support this reliance. Along with this increased reliance, however, comes increased vulnerability. More and more, corporate espionage is targeting information systems. The architecture developed under this effort can be used to support vulnerability analyses of any corporate or commercial information network. Such analyses will provide industry the information they need to thoroughly understand their exposure or design additional safeguards.

KEYWORDS: Information Warfare, Network Security, Modeling and Simulation

DARPA SB991-013 TITLE: All Optical Fiber Optic Backbone for Advanced Data Networks

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Produce a high-speed fiber optic backbone structure that supports the transmission of multiple data protocols between multiple network stations.

DESCRIPTION: Next generation data networks for avionics, ships and other highly integrated multi-sensor platforms will require significant upgrades in data transport capacity, reconfigurability, survivability, etc. Current networks can neither support multiple protocols, nor can they easily be upgraded to new protocols. The current architecture requires multiple parallel wires or fibers to transport data between two stations; for the case of multiple stations (>2), electrical regeneration or electronic hubs are required. The Department of Defense (DoD) has a need for bi-directional redundant high speed (Gb / s) networks that can support multiple protocols, topologies and security levels by providing each of these functions with its own dedicated channel. The goal is to produce a high-speed fiber optic backbone structure that supports the transmission of multiple data protocols between multiple network stations. These stations are “universal workstations” whereby all data in the system is available to all stations without the need for each station to request the data. The approach facilitates the rapid reconfiguration of networks without the need for restructuring the network protocols or topologies.

PHASE I: Validate the concept of an n-station network transmitting m signals simultaneously with different protocols such as Asynchronous Transfer Mode (ATM), Ethernet, and data formats. Demonstrate in the laboratory a minimum system with three nodes and two signals.

PHASE II: Demonstrate and evaluate n (n>20) stations network transmitting m (m>10) signals simultaneously. Incorporate turnable fiber optic sources and tunable fiber optic filters to demonstrate network reconfigurability.

PHASE III DUAL USE APPLICATIONS: PHASE III DUAL USE APPLICATIONS: Develop a low cost network with commercial, off-the-shelf components for DoD and commercial applications. The application of multi-signal optical backbone will enable new means to provide integrated control and support of large integrated commercial platforms; such as ships, commercial airliners, and automobiles, and integrated manufacturing equipment. This technology can potentially replace hundreds of wire or fiber bundles which make up a large part of the touch labor in the manufacturing process of the increasingly complex and computer controlled systems in transportation and manufacturing.

KEYWORDS: Fiber Optics, Networking, Avionics, Communications, Transport Protocols

DARPA SB991-014 TITLE: Smarter Sensors

KEY TECHNOLOGY AREA: Computing and Software; Sensors, 6.2 Exploratory Development

OBJECTIVE: Design, build and demonstrate a prototype sensor system with complementary image understanding components to facilitate automated extraction of information from image data.

DESCRIPTION: With continuing progress in the development of microelectronics and communications technology, it is becoming increasingly inexpensive to acquire, process and distribute digital image data. While many applications are satisfied by acquisition and distribution of a simple picture, more demanding computer vision applications seek to extract information from the imagery: segment and classify objects; detect and track movement of objects; measure shape, size and/or material properties of objects and surfaces. Innovative concepts are sought to embed image understanding components in novel sensor systems to facilitate automated extraction of information from image data. Development of new products for automated extraction of information from image data (e.g., segmentation and classification of objects; detection and tracking of moving objects; measurement of shape, size and/or material properties of objects and surfaces). This goal may be addressed by (1) hybrid configurations that combine novel imaging concepts and complementary image understanding technology, or (2) software-intensive solutions linking novel image understanding processes to commercial-off-the-shelf (COTS) sensors and computational components. Recent imaging sensor innovations include omni-directional catadioptic cameras, scanning laser range finders, board-level stereo camera systems, video polarization cameras, multispectral and hyperspectral scanners and uncooled thermal arrays. Suitable image understanding algorithms, tailored to the unique characteristics of the sensor, hold the potential for achieving low-cost, high-performance capabilities of specific types of applications. Alternatively, software-intensive solutions linking commercial-off-the-shelf (COTS) sensors and computational components with novel image understanding processes may be proposed to address specific terrestrial or airborne applications. In any case, the imaging phenomenology, the processing strategy and the desired capability must be clearly defined for a proposed effort.

PHASE I: Refine concept for a sensor system which couples image understanding components to sensor operating characteristics. Specify targeted commercial and military applications. Identify critical design issues and conduct experiments to establish feasibility. Analyze predicted performance. Deliver a specification, development plan, test plan and cost estimate for the prototype system.

PHASE II: Implement the prototype system as designed. Demonstrate system performance in accordance with test plan. Evaluate accuracy and operating characteristics of the implemented system. Prepare marketing plan for targeted commercial and military applications.

PHASE III DUAL USE APPLICATIONS: With the rapidly increasing use of low-cost, computer-interfaced imaging devices in both commercial and military applications, there is great potential for products that successful automate application-specific image analysis tasks and eliminate the need for exclusive human interpretation. Potential Phase III dual use applications arise in many defense and civilian domains: security surveillance and monitoring; access controls; personal identification and authentication; automated and computer-assisted target recognition; analysis of intelligence and earth resources imagery; autonomous navigation of ground vehicles and robots; cartography; modeling and simulation; law enforcement; medical imaging; and manufacturing process control and quality control. The ability to package increasingly smart sensors as lower-cost system components will address existing market needs for automated and semi-automated vision components while expanding the market for analysis of visual data in many fields.

KEYWORDS: Sensors; Image Understanding; Computer Vision; Real-Time Image Processing.

REFERENCES:
1. DARPA Image Understanding Home Page <http://www.darpa.mil/iso/iu/>
2. DARPA Airborne Video Surveillance Home Page <http://www.darpa.mil/iso/avs/>
3. *Proceedings of the 1997 Image Understanding Workshop*. Morgan Kaufmann Publishers, San Francisco, California. ISBN: 1-5586-490-1.
4. *Proceedings of the 1998 Image Understanding Workshop*. Morgan Kaufmann Publishers, San Francisco, California (in press).

DARPA SB991-015 TITLE: Information System Vulnerability Assessment Tools

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Creation of tools to determine information system vulnerability to cyber attack.

DESCRIPTION: Research and development leading to information system vulnerability analysis tools that enable system security officers and administrators to map information systems, determine overall security posture, and identify vulnerabilities to cyber attack. Further, the developed tools will provide risk-balancing alternatives, i.e., measures that can be taken to offset identified vulnerabilities. Commercial vulnerability assessment tools look for “known” vulnerabilities in specific components. DARPA is looking for assessment tools that look for strategic vulnerabilities in systems including vulnerabilities that are not yet known. Efforts may address any information system analysis methodologies for which significant leverage and increased assurance can be demonstrated. Scalable, comprehensive tools that measure risk factors in a distributed, network-centric computing environment are of particular interest. Efforts may either modify existing codes, algorithms, or tools or create new ones, but in all cases proposals must clearly state how system integrity, availability, and confidentiality vulnerabilities will be identified and measured. Important measurement is how well the tools predict where real red teams attack the system and the level of difficulty they face in successful attack.

PHASE I: Define architectures, methodologies, algorithms, and system level approach to information system vulnerability analysis. Identify potential commercial-off-the shelf (COTS) applications to be integrated into vulnerability analysis tools.

PHASE II: Develop the vulnerability analysis tool(s) including integration of COTS. Demonstrate tool effectiveness and scalability in a DARPA Information Systems Office large scale demonstration such as the Information Superiority Technology Integration (ISTI) series (a series of integration experiments to begin in September 1998 to take on the challenge of creating large integrated systems to meet the tempo and functional challenges of the Chairman of the Joint Chiefs of Staff’s Joint Vision 2010). Complete tool documentation and documentation of test cases and results must be delivered.

PHASE III DUAL USE APPLICATIONS: Effective information system vulnerability analysis tools will have widespread commercial application. All major businesses, world-wide, depend on information systems for day-to-day operations and are increasingly concerned, as is the Department of Defense, about system security and information assurance. A risk assessment tool will be readily marketable in the commercial environment.

KEYWORDS: Vulnerability Analysis, Information Systems, Cyber Attack, Information Assurance, Risk Assessment, Algorithms

DARPA SB991-016 TITLE: Dialog Interaction with Video for Expert Knowledge Transfer

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: To develop, demonstrate and evaluate a method for cost-effective interaction with humans possessing special expert knowledge who are captured on video (e.g. Colin Powell). The focus is on using spoken language dialog interaction for information access and extraction of lessons learned.

DESCRIPTION: Microprocessor, digital video, and speech recognition technologies have progressed to the point that it is now possible to engage in simulated problem-solving interaction with video characters. There are a plethora of opportunities to employ this method in communications and training in the Government and private sector. This effort will define a cost-effective method for using these technologies in a "lessons learned" environment. The method must support individualized, active user participation in simulated situations. The concept for operation is that expert knowledge in the form of individuals recorded on video will be available to users through a natural, voice-driven human/computer interface. Scenarios concerning military and commercial affairs of national interest will be developed and field tested to: 1) Determine user acceptance of this technological approach to knowledge gain; and 2) Measure the efficiency and effectiveness of the overall learning gain from this virtual reality approach to knowledge transfer. The research will also include the investigation of reuse of existing video footage for these programs.

PHASE I: Develop a prototype of a system that supports dialog interaction with a person captured on video used to gain "lessons learned knowledge". For example the interaction may be with a logistics planner captured in video who would answer both general and specific questions of how to plan logistics support for a crisis response civilian evacuation. The user would be a military office in staff college who is focusing on joint planning. There must be a plan to conduct an experiment to determine user acceptance of the method.

PHASE II: Expand the prototype into a series of expert knowledge programs. Evaluate the efficiency and effectiveness of the learning gain achieved from the method with rigorous, controlled experiments.

PHASE III DUAL USE APPLICATIONS: Demonstration of this technology and its potential provide significant educational benefits in a broad spectrum of training applications in both commercial and military environments.

KEYWORDS: Human Systems Interface, Dialog Interaction, Expert Knowledge Transfer, Speech Recognition, Simulated Problem-Solving Interaction

DARPA SB991-017 TITLE: Computationally Efficient Detection of Vehicles in High Clutter Environments in Synthetic Aperture Radar Imagery

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of robust target detection systems capable of mitigating naturally induced false alarms in medium resolution magnitude-detected microwave synthetic radar imagery from airborne collection systems, and for automated use of scene context in Foliage Penetration (FOPEN) Synthetic Aperture Radar (SAR) imagery to detect camouflaged or concealed targets.

DESCRIPTION: Research and development leading to unique algorithms and software systems that are capable of detecting (with very high confidence and low false alarm rates) radar signatures of both individual and groups of vehicles in areas with significant background clutter density resulting from target-like natural and man made objects. Efforts should focus on computationally efficient algorithms capable of real time implementation, utilizing magnitude detected imagery of 1m IPR or greater. Efforts of interest include post-detection filtering to eliminate vegetation-induced false alarms; novel detectors to permit detection of closely spaced targets and unique approaches to the rapid rejection of false alarms induced by man-made confusers. It is desirable to further automate rejection of false alarms through the use of context to reduce the number of image analysts required and the volume of data, which must be recorded or data linked to the ground. Much of this contextual information such as roads, tree-lines, lakes, terrain slope, vegetation density, etc., can be extracted from radar imagery. This information is then used in conjunction with an object detection, and is used to rank the likelihood that the object is a target of interest. In addition to in-scene features, such information may be extracted from archived FOPEN or conventional Radar and Electro-Optical (EO) surveillance. These approaches should be designed to serve as the initial screening approach for multistage automated/assisted target recognition/imagery analysis systems. Efforts may either modify existing codes, algorithms, or tools or create new ones, but in all cases proposals must clearly state what improvements are expected over approaches in the current literature for what real world data sets and scenarios.

PHASE I: In detail, define the approach, algorithm, and quantify the expected detection performance benefits through simulation and experiments with limited data sets.

PHASE II: Create a real time implementation of a tool that embodies the algorithm and demonstrate the performance on significant data sets collected from an operational surveillance platform. Analyze and document performance.

PHASE III DUAL USE APPLICATIONS: The development of advanced detection approaches for use with airborne sensors offers significant advantages in the growing application of airborne remote sensing data to problems such as land use planning, demographic analysis and disaster relief planning. Efficient detection approaches would permit automated analysis of vehicle density and other key metrics from remote sensed data; thereby greatly reducing the scope of the labor and skill intensive imagery analysis required to convert raw data into marketable products. It is expected that such improvements would result in greatly reduced cost and significantly increased timeliness for geospatial information derived from remote sensing.

KEYWORDS: Imagery Analysis, Target Detection, Synthetic Aperture Radar, Automated Target Recognition, Foliage Penetration Radar

DARPA SB991-018 TITLE: Robust Adaptive Control Technology for Dependable Systems

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Technology for (1) Commodity software-enabled controllers for autonomous systems, and (2) self-improving systems

DESCRIPTION: Innovative R&D is sought for: (1) Constructing dependable software-based control systems to meet the demands of Defense applications that must push performance envelopes and coordinate actions while operating under highly unpredictable circumstances. Of interest are (a) strategies for robust, adaptive control that is readily tailored to a specific application; (b) approaches that exploit physical/engineering models for the accurate description, prediction and sensing of subsystem status and environmental conditions; and (c) mode design and coordinated mode transition management for integrated and cooperating systems. The control strategies should be realized in the form of a toolkit enabling rapid construction of controllers for autonomous applications along with benchmarks to evaluate a system's ability to perform its assigned tasks under various conditions, reliably and safely. (2) Self-improving and self-correcting software systems. Self-improving software evaluates its own behavior and changes behavior when it is not accomplishing its goals or when better functionality or performance is possible. The adaptivity should not require specific adaptive techniques such as neural networks or genetic programming, but instead rely on knowledge of the software's mission, construction, and behavior. Runtime management for adaptivity should be addressed.

PHASE I: Demonstrate feasibility of concepts on a relevant application providing convincing evidence of an innovative, dependable software-based control or auto-adaptation capability not otherwise attainable. Define benchmarks and quantitative evaluation strategy. Complete detailed design of control software toolkit and/or auto-adaptation runtime system and implementation plan.

PHASE II: Implement in full and demonstrate the technology on relevant application on a commodity processor. Full documentation is required of the innovative technology developed and an operational description for the demonstration application. Evaluate the system performance.

PHASE III DUAL USE APPLICATIONS: Commercial applications benefiting from this research include vehicle control, environmental control, medical monitoring and support systems, security systems, robots, and electronically integrated systems of consumer products. Military applications that should benefit from the research include integrated avionics and flight control, autonomous or semi-autonomous multi-vehicle systems, electronic warfare countermeasure systems, automatic target recognition, autonomous sensor/actuator systems, and control of micro-electromechanical systems for detection of biological and chemical agents.

KEYWORDS: Control Systems, Distributed Control, Software Controllers, Adaptive Systems, Distributed Systems, Agent-Based Software, Autonomous Systems

DARPA SB991-019 TITLE: Network Management

KEY TECHNOLOGY AREA: Computing and Software

OBJECTIVE: Technology for automatic diagnosis and correction of network problems

DESCRIPTION: Computer networks that tie together organizational information resources
are increasingly complex in their services and increasingly fragile, due to inefficient resource use resulting in poor performance or from direct attacks that misappropriate or stress resources. DARPA solicits research into the use of distributed, cooperative pattern-matching and reasoning systems that can represent performance and security constraints and models in a unified framework and automatically diagnose and correct problems. Such systems must be inherently robust by being able to resolve inconsistent views, by dynamically adjusting monitoring capabilities, and by using a federated and dynamic processing model that does not require central control. The system must take into account its own dependencies on the network substrate as part of its reasoning and corrective procedures.

PHASE I: Develop the pattern matching capability in the domain of network elements (routers, hubs, bridges, firewalls, etc.), represent the constraints of performance and security for at least 10 elements, and demonstrate the distributed problem-solving capability for at least three denial of service attacks described by CERT (the Computer Emergency Response Team organization) within the previous 18 months. The corrective actions taken after the diagnosis should leave the system in a state that satisfies (perhaps only minimally) the performance and security requirements of the organization. The architecture should be easily extensible and capable of eventually handling up to 10,000 network elements.

PHASE II: Develop a prototype for a commercial product that could interoperate with other network management and security maintenance tools.

PHASE III DUAL USE APPLICATIONS: Commercial applications benefiting from this research include network diagnostic and management and security management tools.

KEYWORDS: Network Management, Security Management, Network Diagnosis, CAD, Network Survivability, Self-Configuring Networks

DARPA SB991-020 TITLE: Human Information Interaction

KEY TECHNOLOGY AREA: Human Systems Interface

OBJECTIVE: Address one or more of the following capabilities.: (1) Develop innovative techniques for high precision discovery, search, and retrieval of multimedia information accessible via the World Wide Web; (2) Create a device to allow individuals and groups to view stereographic displays with the unaided eye.

DESCRIPTION: (1) High Precision Web Search. Information discovery, search, and retrieval technology is rooted largely in algorithms built for centralized, relatively homogeneous collections. These algorithms do not scale well to the needs of users depending on highly distributed, heterogeneous, multimedia resources such as the World Wide Web, particularly in time-critical situations. This subtopic seeks innovative approaches that enable Web-accessible, multimedia information resources to be retrieved quickly and precisely, without overlooking key sources. (2) Unencumbered Viewing of Stereographic Displays. Research and development leading to the design and prototyping of mechanisms and display devices that enable individuals and groups to view stereographic displays without wearing shutter glasses or polarizing glasses. Efforts may address any novel approaches that will enable people to view stereographic displays without the aid of glasses, goggles, or other encumberances. Efforts of interest include techniques for allowing both individuals and groups of between two and ten people to comfortably view stereographic displays. Efforts may either modify existing techniques and devices or create new ones, but in all cases proposals must clearly state what specific viewing characteristics are expected for what types of display devices and under what conditions.

PHASE I: (1) High Precision Web Search. Evaluate the feasibility and effectiveness of the proposed concepts through analytical studies or empirical experiments. A successful Phase I will have rigorously tested the proposed ideas in a laboratory environment and will demonstrate significant performance improvements over current approaches, using well-defined metrics to be included in the initial proposal. (2) Unencumbered Viewing of Stereographic Displays. In detail, define the proposed technique for allowing unencumbered viewing of stereographic displays. Produce a prototype suitable for use by a single individual.

PHASE II: (1) High Precision Web Search. Build a scaleable prototype for the WWW and evaluate its utility for crisis intervention and management. A successful Phase II will engage a Defense customer in the test and evaluation phase, will evaluate the prototype's performance in a realistic setting, and will report performance using metrics derived from those initially proposed. (2) Unencumbered Viewing of Stereographic Displays. Extend the prototype to enable unencumbered viewing of stereographic displays by groups of up to ten people. Apply the prototype to a military scenario such as shared viewing of a stereographic sandtable. Complete documentation of test cases and results must be delivered.

PHASE III DUAL USE APPLICATIONS: (1) High Precision Web Search. The WWW continues its geometric growth world-wide, both in terms of its total number of users and the information accessible. Significant improvements in information organization, indexing, discovery, search, and retrieval, considering not only the attributes of the information but also the characteristics of the end user are of great value to essentially every Web user. In particular, those users whose work is driven by specific, time critical, strategic or tactical requirements will benefit most directly. This specifically includes Defense analysts, but also includes all serious information users dependent on high quality network-accessible information. (2) Unencumbered Viewing of Stereographic Displays. The development techniques and devices for unencumbered viewing of stereographic displays will expand the commercial markets for both stereographic imaging and television systems. Availability of such techniques and related devices could significantly improve the ability of pilots to interpret 3-D data displays in airplane cockpits.

KEYWORDS: (1) High Precision Web Search: Information Discovery, Search, Information Retrieval, Intelligent Agents, Filtering, Metadata, Digital Libraries, Categorization, Query Formulation. (2) Unencumbered Viewing of Stereographic Displays: Stererograhic Displays, 3-D Imaging, Shutter-Controlled Lenses, Polarizing Lenses, Eyes-Free Viewing Systems.

DARPA SB991-021 TITLE: Low-Profile/Conformal Antennas for Ultra-Wideband Airborne Sensors

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Develop electrically small, low profile antennas in the HF/VHF/UHF bands to maximize angle-time-frequency diversity in multi-mode airborne applications.

DESCRIPTION: Perform research and development leading to innovative antenna solutions for airborne applications, including Unmanned Aerial Vehicles (UAVs). Sensor applications include Counter Camouflage, Concealment and Deception (CC&D), Synthetic Aperture Radar (SAR), Ground Moving-Target-Indication (GMTI), and passive location of emitters / targets. Adaptive nulling of jammers and Radio-Frequency Interference (RFI) and Space-Time Adaptive Processing (STAP) techniques allow detection of slow ground targets within the main beam clutter and stationary targets in heavy interference. Similar processing allows the isolation and location of targets based upon passive detection of onboard emitters. These techniques, however, require very high percentage bandwidths, and long (in wavelengths) spatial extents. Much of the aircraft skin may need to be occupied by antennas. Thus, innovative solutions to achieve required performance (bandwidth and gain) without intruding into the air-stream or the interior of the aircraft or UAV are needed. High instantaneous bandwidth performance is desirable, but very fast switchable/tunable solutions are suitable in many applications.

PHASE I: In detail, identify enabling technologies, system approach, and paper design. Demonstrate performance through electromagnetic modeling and simulation or scaled models.

PHASE II: Manufacture and test a prototype of an antenna. This must include calibrated amplitude and phase measurements over 4 pi sterradians and over the intended frequency band.

PHASE III DUAL USE APPLICATIONS: Ultra-wideband SAR is being developed under the DARPA GeoSAR program and future systems and upgrades to better operate in heavy interference. Other civilian and commercial applications include law enforcement, counter-drugs, and search-and-rescue.

KEYWORDS: Conformal, Low-Profile, Antennas, Arrays, STAP, Wide-Band, SAR, GMTI, Radar

DARPA SB991-022 TITLE: High - Low Altitude Single Soldier Precise Delivery Systems

KEY TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Design/develop single soldier precise delivery systems capable of insertion from high or low altitudes.

DESCRIPTION: Existing airborne/air assault delivery systems rely on parachute or helicopter based delivery systems to position soldiers in tactical environments. These delivery systems however often place units/soldiers in a vulnerable position, and result in a linear (airborne drop zone) or group based (air assault insertion point) delivery. An alternative to this would be to develop delivery systems for soldiers that deliver them to the precise position at the correct time to initiate tactical combat operations in a novel way. Efforts to develop automated glider or low thrust based manned delivery systems for the single soldier from 5,000 to 70,000 feet are of interest. Systems would be highly survivable, possess autonomous positioning capability (within 10m), organic sensor capabilities Electro-Optical/Infrared/Radio Frequency (EO/IR/RF), organic communications, and capable of transporting up to 300 lbs. of soldier and combat equipment. Of course these delivery systems must be capable of providing for the health maintenance of the soldier to be delivered to the surface, in terms of shock {g-forces}, oxygen, etc. As an automated system, the occupant would not be “in the control loop”. The system would be survivable against a variety of threats, in terms of signature management and materials, and must survive the shock of deployment and landing, so as to be capable after retrieval of subsequent reuse. Efforts of interest include horizontal to vertical glide/thrust ratio of 10:1 or greater (in order to provide significant standoff delivery capability). Innovative research and technologies in the areas of advanced glider techniques and materials, autonomous flight control systems, lightweight/thermally resistant/frequency selective materials, miniature low power sensors, novel thrust mechanisms and shock removal techniques {for human health maintenance} would be an integral part of such a concept and are highly desirable.

PHASE I: Concept definition and preliminary design of delivery systems. Quantify expected benefits through design, and simulation/modeling. Focus on aeronautics, environment and soldier survivability capabilities.

PHASE II: Critical design and sub-scale prototype development. Conduct preliminary analysis of navigation/positioning, communication, and sensor capabilities.

PHASE III DUAL USE APPLICATIONS: The development of precise soldier delivery systems will be leveraged into markets providing delivery capability for firefighters into remote regions, or environmental disaster areas. The development of these type of systems could also be leveraged into entertainment markets or as alternatives for sport parachuting, hang gliding, and traditional gliding.

KEYWORDS: Manned Airborne Systems, Glider, Combat Systems

DARPA SB991-023 TITLE: Technologies Enabling Development of Affordable High-Speed Air Vehicles

KEY TECHNOLOGY AREA: Air Vehicles/Space Vehicles

OBJECTIVE: Creation of affordable high-speed air vehicle concepts.

DESCRIPTION: Research and development of key technologies which lead to revolutionary high-speed air vehicle concepts. Efforts should address the application of such technologies to long range, high supersonic and hypersonic air vehicles, but innovative approaches which lead to revolutionary, affordable hypersonic vehicle concepts are of particular interest. Efforts of interest include technologies which enable smaller, lighter or more efficient vehicle designs or innovative propulsion systems. Efforts should include execution of critical experiments to demonstrate key technologies in ground or flight test.

PHASE I: In detail, define how application of the proposed technology to the design of a high-speed air vehicle makes it affordable, including a conceptual vehicle design, and quantify the expected benefits over similar, existing vehicle designs.

PHASE II: Perform technology developments and demonstrations of critical technologies which increase the technology readiness and reduce the development risk of affordable high-speed air vehicles. Improvements in analytical tools and analyses over those in Phase I should be demonstrated. Vehicle designs should be matured and benefit analyses refined to reflect the results of developments and demonstrations. Complete documentation of the results of tests, analyses and design studies must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of affordable high-speed air vehicles will expand the commercial markets for passenger and cargo aircraft. Dramatic reductions in travel time between the United States and Pacific Rim destinations would offer significant economic and political benefits.

KEYWORDS: Weakly-Ionized Gas, Hypersonics, Affordable

DARPA SB991-024 TITLE: Three-Dimensional Image Projection

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of a three-dimensional, color-image projection system that creates convincing images in air.

DESCRIPTION: A tactical 3-D volumetric display system for theater use will spread disinformation and impose surprise on enemy forces, as well as improve friendly force survivability and increased lethality. This requires development of real, opaque, 3-D images in open atmosphere. Image opacity, for hidden line obscuration, is essential for the realism of the projected images, and to provide a wide viewing angle. An experimental study of the image opacity and intensity must be performed to develop and define image projection requirements for generation of real images.

PHASE I: A detailed feasibility analysis is required. This study should include a physics-based quantitative assessment of opacities achievable, size scales (of images and range to the projection system), and color rendering ability as a function of atmospheric and lighting conditions (ranging from indoor environmentally controlled to field environments).

PHASE II: Demonstrate the ability to generate complex volumetric images in air. This demonstration should quantitatively assess how real the image appears under various (and varying) environmental conditions, and as a function of range to the image.

PHASE III DUAL USE APPLICATIONS: A wide range of Dual-Use opportunities exist, including; movie making, advertising, computer games, virtual reality, remote conferencing, and immersive training.

KEYWORDS: Image Rendering, Image Projection, 3-D Image, Denial and Deception, Volumetric Display

DARPA SB991-025 TITLE: Collision-Avoidance Sensors for Micro Air Vehicles

KEY TECHNOLOGY AREA: Air Vehicles

OBJECTIVE: Develop collision-avoidance sensors for Micro Air Vehicles.

DESCRIPTION: Micro Air Vehicles (MAVs) are defined by DARPA to be affordable military air vehicles less than 15 cm in length, width or height, that are capable of performing useful military missions such as local area reconnaissance. They are envisioned to be operated by the individual soldier in the field. For missions in urban and other confined environments, these autonomous vehicles will require collision-avoidance sensors to prevent collision with obstacles like walls, poles, and wires. MAVs include both fixed-wing and hover configurations. Typically, fixed-wing vehicles will weigh less than 100 grams and hovering MAVs are likely to weigh less than 300 grams. To meet typical weight and power constraints for MAVs, collision-avoidance sensors are likely to have to weigh less than 10-40 grams and to require less than 1-2 watts of average power. Obviously, the less the better. Range out to 50 meters is desirable, with update rates of 1 kHz or better. Ideally, the sensor system should recognize ground and distinguish it from approaching obstacles, and facilitate maneuver in cluttered environments like urban canyons or sparsely forested terrain.

PHASE I: Develop a detailed design for an MAV collision-avoidance sensor system and a plan to build and test the system. Describe expected performance. Show feasibility of the concept, and identify major barriers to be overcome.

PHASE II: Build an MAV collision-avoidance sensor system and demonstrate it in a suitable flight test vehicle (such as a model airplane).

PHASE III DUAL USE APPLICATIONS: It is anticipated that MAVs will find a host of civilian as well as military applications, such as aerial photography, and fire, police and rescue operations. Collision-avoidance sensors may also serve as altimeters or ranging devices that will facilitate MAV civilian applications.

KEYWORDS: Micro Air Vehicles, Collision Avoidance, Range Sensors

DARPA SB991-026 TITLE: Rankine Bottoming Cycle for Military Diesel Engines

KEY TECHNOLOGY AREA: Ground Vehicles

OBJECTIVE: Advanced research of Rankine Bottoming Cycles for highly-compact and increased-efficiency diesel engines.

DESCRIPTION: Modern military diesel engines use 4-valve, direct-injection, turbocharged technology to achieve power densities of 2 to 3 lbs/hp at peak thermal efficiencies of 38 to 42%. Ongoing DARPA programs are seeking higher diesel efficiencies and power densities through electro-turbo compounding and high-pressure cycles. If fully successful, these programs will boost efficiency to levels approaching 50% at power densities of 1.5 to 2.0 lbs/hp. Given the most aggressive development progress, the 50% thermal efficiency results in 9,550 BTUs of exhaust and radiator waste heat for every pound of diesel fuel burned. This waste heat requires an additional parasitic power to operate cooling fans and also results in a thermal signature that is undesirable. Past investigations of Rankine Bottoming Cycles for diesel engines have resulted in complex and bulky systems that would not fit within a combat vehicle. The present effort seeks to develop highly-compact solutions that integrate the full-vehicle thermal management function and result in net volume reductions and fuel economy increases.

PHASE I: Preliminary design of full power system including: thermodynamic calculations, detailed design of critical components, Computer Aided Design (CAD) layout with weight and volume estimates.

PHASE II: Design, build and test for 100 hrs. prototype developed in Phase I over power and environmental conditions. Provide estimate of production cost, weight and volume in production scale.

PHASE III DUAL USE APPLICATIONS: Dual use applications for this technology include both commercial ground and maritime vehicles. The fuel economy benefits realized by the higher operating efficiencies will be very attractive to the commercial market. Reduction in net volume will also be attractive to manufacturers of smaller systems.

KEYWORDS: Diesel Engines, Rankine Bottoming Cycle, Power Densities, Turbo-Charge Technology, Thermal Management, Thermal Efficiency, Fuel Economy, Combat Vehicle

DARPA SB991-027 TITLE: Wavefront Sensing for Closed-Loop Adaptive Optics in Extended Scenes

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of real-time adaptive optics for imaging seekers using only extended scenes.

DESCRIPTION: There are many missiles that have imaging seekers. Because of the seeker's operating environment, the imagery is significantly degraded by a variety of causes including boundary-layer turbulence, thermal heating of the window and optical elements, and jitter. There is a need for on-board adaptive optics (AO) which would correct optical aberrations in real-time and thus allow one to retrieve fine-resolution imagery. Improved imagery delivered in real-time would significantly increase performance of the seekers, particularly in the final stages of aim-point selection, and allow for a dramatic enhancement of surgical capabilities in a tactical setting. Conventional AO (widely used in astronomy) uses wavefront sensors (WFS) which rely on a point-like beacon being in the scene. In many missile scenarios, extended scenes are available but there is no beacon available (e.g., air-to-ground, ground-to-ground missiles). Furthermore, the update rates of the missile seeker can be in the hundreds of hertz stressing both the signal-to-noise (due to short integration times) and processing power needed to minimize latency. Thus there is a need for an AO system which uses a WFS able to operate on extended scenes with update rates up to several hundred hertz.

PHASE I: In detail, define the algorithm for exploiting extended scene imagery to adaptively compensate for degradation in imagery. Quantitatively assess the image quality enhancement expected for an environment typical of air-to-ground and ground-to-ground seekers. Estimate the computational burden (including memory, I/O throughput, and processing power) necessary to develop a real-time capability for a system operating at hundreds of hertz. Assess the aim point accuracy achievable by employing this real-time AO system.

PHASE II: Create a laboratory brass-board system of the AO. Perform a series of tests that accurately simulate the boundary-layer turbulence, thermal heating, and jitter anticipated in a fielded missile system. Quantify the actual performance enhancement gained by using the developed AO algorithm and compare with the predictions provided under Phase I. Explain any discrepancies between predicted and actual results.

PHASE III DUAL USE APPLICATIONS: The technology developed under this SBIR, would also have applications in manufacturing scenarios that rely on real-time inspection/monitoring in environments where there are dynamically changing aberrations. A specific example of such an application is that of monitoring a manufacturing process in an oven. It would also benefit the astronomical and military space surveillance community where observations of extended objects (e.g., planets, nebulae, or satellites) is desired and no guide stars are within the field-of-view of the sensor.

KEYWORDS: Adaptive Optics, Imaging Seekers, Missile Sensors, Optical Aberrations, Optical Turbulence

DARPA SB991-028 TITLE: Airborne Free Air Turbulence Measurement Device

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of an aircraft onboard, clear air turbulence mitigation system capable of accurately predicting turbulent disturbances along the aircraft flight path and calculating the appropriate control surface response to minimize turbulence induced loading.

DESCRIPTION: Research and development leading to a prototypical onboard aircraft turbulence mitigation system. Efforts may address various Light Detecting & Ranging (LiDAR) and/or radar techniques, or it may include other innovative approaches to measure flow fields. Research should be focused on: (1) making accurate 3-D turbulent velocity measurements with a spatial accuracy and look ahead distance appropriate for aircraft responses (work in this area should build upon current NASA sponsored flight testing), (2) calculating optimal control system responses that minimize aircraft loading and displacement, (3) proving the concept via flight testing, and (4) analyzing potential aircraft design that is optimized (reduced structure, longer airframe life, enhanced operation in adverse conditions, ….) to take advantage of the turbulence mitigation technology. Research should include a comparison of the measured turbulence to an aircraft's actual response for various look ahead distances and turbulent events. Also, the system's ability to function in all weather conditions (clouds, rain, smoke, etc.) should be proven.

PHASE I: Analyze potential system concepts. Estimate reducing G-loading levels in different turbulence conditions via simulation. Determine sensor and control surface requirements. Determine potential system utility in potential DoD applications (transport, reconnaissance unmanned aerial vehicles (UAVs), carrier landing, etc.

PHASE II: Design, build, and flight test a proof-of-concept system capable of measuring the 3-D turbulent velocities ahead of an aircraft and reducing G-loading. Data should be collected which compares the sensor measurements with the actual event as seen by the aircraft to allow validation of modeling approach. Detailed modeling of DoD applications should be performed.

PHASE III DUEL USE APPLICATIONS: This type of turbulence measurement device could be incorporated into an aircraft's flight control system as part of a predictive turbulence mitigation system. The goal is to dramatically reduce the loads on the aircraft through the use of the control surfaces. This could have dramatic effects both for passengers of civil aircraft as well as military passengers and pilots on long low altitude flights. In addition, this system could be used to reduce the required structural strength of a UAV by limiting the peak loads that aircraft will face. The lighter aircraft could therefore have a longer endurance or carry additional payload.

KEYWORDS: Atmospheric Turbulence, Clear Air Turbulence, Doppler LiDAR, Doppler Radar, Gust Alleviation, Turbulence Mitigation

DARPA SB991-029 TITLE: Actuator Technologies for Micro-Adaptive Flow Control

KEY TECHNOLOGY AREA: Air Vehicles

OBJECTIVE: Develop new, active, flow-control actuators that perform large-scale flow control with small-scale flow manipulations.

DESCRIPTION: Micro Adaptive Flow Control (MAFC) is defined by DARPA as the control of large-scale flow fields using small-scale actuators in highly sensitive regions of the flow field. By combining innovative flow-actuator technologies with adaptive control strategies, DARPA seeks to develop flow-control technologies with the potential for radical gains in aerodynamic or hydrodynamic performance. Robust actuators are needed to enable realization of these technologies in systems-level applications that may include aircraft, maritime vehicles, munitions, and engines. Emerging technologies like Microelectromechanical Systems (MEMS) and Smart Materials have enabled exploration of new concepts for flow actuation. Substantial performance gains have been indicated by several research efforts (ref. 1-3). It is the intent of this SBIR to expand the current set of active flow control devices. Proposed actuator designs should be capable of effective operation under flow conditions, power levels, displacements, forces and bandwidths that are commensurate with real systems-level applications. Proposals should describe proposed actuator technologies and anticipated performance benefits in the context of particular systems applications and operating conditions.

PHASE I: Define a plan to manufacture active flow-control actuators and a plan to benchmark the actuator performance. Estimate the expected performance of the actuator and define the systems application for it.

PHASE II: Build the actuator and test it under realistic flow conditions relevant to the applications described in Phase I.

PHASE III DUAL USE APPLICATIONS: It is anticipated that new actuator technologies will build new markets for MAFC technology by enabling performance gains in aircraft, maritime vehicles, munitions, and engines. Potential areas of enhanced performance include higher lift, greater maneuverability, reduced drag, greater range, lower noise, higher thrust to weight ratios, and greater precision. Many of these will have civil as well as military applications.

KEYWORDS: Micro Adaptive Flow Control, MEMS, Smart Materials, Aircraft, Maritime, Munitions, Engines, Actuators

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DARPA SB991-030 TITLE: Feedback-Controlled Predistortion Linearizer for Microwave Power Amplifier

KEY TECHNOLOGY AREA: Command, Control and Communications (C3)

OBJECTIVE: Development of feedback control of a predistortion linearizer to maintain optimal predistorter tuning.

DESCRIPTION: High data rate Radio Frequency (RF) communication systems exploit bandwidth-efficient modulation schemes, which, in turn rely on highly linear power amplifiers. Linearization schemes are used to reduce distortion with minimum loss of amplifier efficiency. Predistortion is a proven linearization technique, but it is incapable of compensating for changes in power amplifier characteristics. By augmenting a predistortion linearizer with feedback control, optimal tuning of the predisdorter can be maintained despite power amplifier drifts caused by aging, temperature variation, or other factors.

PHASE I: Evaluate candidate approaches, including different predistorter topologies and various feedback schemes. Select one approach based on linearity, subsystem efficiency, and producibility.

PHASE II: Build a breadboard linearized amplifier based on the approach selected in Phase I, and measure its performance when exposed to temperature variations and other variations designed to simulate the effects of aging. Compare the measured performance with the results predicted in Phase I, and use the results to carry out one iteration of the design.

PHASE III DUAL USE APPLICATIONS: The technology developed in this SBIR could be used in space-based or terrestrial communications systems. There would be immediate application to commercial systems that use multiple carriers per channel, such as cellular telephone base stations, and communications satellites serving mobile users. This technology would also be very useful in bandwidth efficient modulation schemes such as n-QAM.

KEYWORDS: Predistortion Linearizer, Linear-Power Amplifier, Multi Carrier Power Amplifier

DARPA SB991-031 TITLE: Shock-Tolerant Auxiliary Bearing for Magnetic-Bearing Suspensions

KEY TECHNOLOGY AREA: Surface/Under Surface Vehicles/Ground Vehicles

OBJECTIVE: Develop a shock tolerant auxiliary bearing to support magnetic bearings for applications such as flywheel energy storage devices for vehicles.

DESCRIPTION: The development of robust, flywheel-energy storage systems for transportation and high-pulsed power applications requires shock-tolerant auxiliary bearings integrated with magnetic bearings for long life and low-power loss. In particular, for military vehicles the auxiliary bearings must be able to sustain numerous, high-speed shock transients without adversely impacting flywheel system performance. The auxiliary bearings must be very reliable and safe. The auxiliary bearings also provide primary rotor support in the event of a failure of the magnetic-bearing suspension. Magnetic-bearing technology is emerging. This solicitation relates to the auxiliary bearings either separately or integrated with magnetic bearings. Typical military flywheel rotors under development weigh 500-800 pounds, spin at 20,000-25,000 RPM, and have an “inside-out” topology (i.e., the machine stator is inside the rotor).

PHASE I: Develop a concept design supported by appropriate analysis, develop assembly concepts, develop concept designs for a test rig, and specify a test plan. Physical experiments are not required for Phase I, but would improve likelihood of selection for Phase II.

PHASE II: Build, demonstrate and characterize the bearing designed by Phase I. Show that the bearing is robust, safe for flywheel use, and compatible with flywheel requirements. Identify specific flywheel designs to which the bearing will apply.

PHASE III DUAL USE APPLICATIONS: The primary military application is energy storage for hybrid electric-power systems for combat vehicles. The same bearing can be applied to military non-combat vehicles and commercial vehicles, although without the extremely high-pulse power requirements. Application is also possible to other high-performance rotating machinery such as turbines.

KEYWORDS: Flywheel, Bearing, Magnetic Bearing, Energy Storage

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